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METHOD OF DETERMINING UNBALANCE IN AC BRIDGES

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[A digest]

In apparatus used for measuring and recording the electrical conductivity of electrolytes, the deformations of machine parts, and the temperatures of various devices, AC bridges are widely employed. Recently, unbalanced as well as balanced bridges have been widely used. The use of the former, however, is complicated by the necessity of using complex electronic apparatus for amplification and detection of signals taken from the diagonal of the bridge.

A simple and sufficiently sensitive device for measuring and recording the unbalance of AC bridges was developed by the authors. Its operation is based on the compensation method of measuring the amplitude of the voltage produced across the input resistance of the apparatus. Essentially, this method consists of compensating the AC voltage by DC voltage from a potentiometer. Its successful realization depends on a sensitive indicator which responds to the difference in amplitude between the AC voltage being measured and the DC voltage taken off the potentiometer. A vacuum-tube oscillator with feedback (tickler), used by the authors for balanced bridges served as such an indicator.

In the grid circuit of the oscillator, a grid condenser is inserted in series with the LC oscillatory circuit, while the grid leak goes through two RC parallel circuits (in cascade) connected on the lower side to the slide of the potentiometer which supplies the grid bias. The condensers in the RC circuits provide a low-impedance path for high frequencies.

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The circuit [illegible] that the circuit oscillates discontinuously, at a frequency determined by the voltage on the grid relative to the cathode.

The circuit is readied for operation by adjusting the grid bias until the oscillator is on the threshold of discontinuous oscillations. The AC voltage being measured is then applied across the upper RC cascade.

Pulsations of voltage on the grid of the tube cause discontinuous oscillations whose frequency increases as the amplitude of the voltage being measured increases. The measuring process consists of compensating the AC voltage being measured by a DC voltage taken from a potentiometer and applied to the lower RC cascade until balance is achieved. Compensation is indicated when the pulsations of discontinuous oscillations return to a very low frequency (null condition).

The indicator proved to be very sensitive to the difference in amplitude between the AC voltage and the DC compensation voltage. The change in frequency of the oscillations under optimum conditions makes it easy to detect aurally differences measured in millivolts or even tenths of a millivolt.

The equally sensitive recording device is equipped with a rotating cylinder with suitable paper attached. As the cylinder rotates, the recorder moves at a constant rate along its generatrix. At one end of the cylinder shaft is the potentiometer winding which supplies the compensation voltage. The rotation of the cylinder is so arranged that the compensating voltage changes from maximum to minimum during each revolution. When the compensating voltage is larger than the AC voltage, the oscillator is cut off; when they are equal, the oscillator gives its first oscillatory impulse and continues to produce impulses at increasing frequencies as the compensating voltage decreases.

These impulses are recorded as a series of dots on the paper. The initial dot of each series fixes the amplitude of the voltage, while the line of initial dots forms an easily perceptible time curve of the phenomenon under study.

This recorder may also be used with small DC voltages, for example, to record thermoelectromotive forces. In this instance, the DC voltage being measured is applied to the first RC cascade in place of the AC voltage.

This compensation method for measuring AC voltages was used by the authors in apparatus built for the Chair of Experimental Physics of Kazakh State University. A description of this apparatus follows.

As is known, dynamic condenser electrometers are based on the periodic change in the capacitance which is charged by the current being measured. In these instruments, the mechanical energy expended by the vibration of the condenser is converted into AC electrical energy which is amplified and measured after rectification. The use of a compensating measuring device for the AC voltage simplifies the amplifier circuit preserving relatively high voltage sensitivity.

The electrometer designed utilizes a stage of AC preliminary amplification between the compensating measuring device and the condenser consisting of a vibrating electrode. The electrodes of the condenser are vacuum-sublimated from a filament in the condenser tube housing to the lower half of the internal surface of a spherical shell and the lower half of a concentrically placed ball. The electrode from the ball is led out through an elongated capillary tube and the structure is designed in such a way that the ball goes into harmonic oscillation whenever the outer shell is deflected by periodic forces. Consequently, the distance between the electrodes and the capacitance varies accordingly.

This circuit was at first intended for detecting aurally the exact moment of compensation of the AC voltage being measured by the DC control voltage. It is contemplated that automatic recording, according to the above scheme, will be incorporated into the instrument at some future date.

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